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Respiratory Adaptation In Wetland Insects

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Abstract

The objective of this research is assessment of respiratory behavior of insect. Aquatic insect shows adaptation to live in the environment. They respire through gills or in some insects respire through caudal style. The study reveals that aquatic flies start life in aquatic habitat, grow in this media and lead terrestrial life on different ecological niche. Hence the present work will fill up the lacunae in literature of aquatic insects.

Keywords : Wetland, aquatic insect, Respiration, adaptation.

Pages: 5 References: 15

INTRODUCTION

Insects are the most common multicellular lower invertebrate animals on the planet and there are millions of different species inhabiting in terrestrial and aquatic habitats and most diverse group of organisms in aquatic environment. Aquatic insects complete their life cycle partially or wholly depending on requirement of their life stage. Even in aquatic circumstances insects feed and lead physiological work including reproduction in the same ways as other terrestrial insects. However, some diving insects such as predatory one can hunt for food under water where land living insects cannot compete. Living aquatic insects represent twelve insect orders. More than 5,000 species are estimated inhabiting inland wetland of India.

Aquatic insects of inland wetland comprise well known groups like may flies of Ephemeroptera, dragon flies of Odonata and Cadies flies of Trichoptera. Aquatic

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insects such as dragon flies and damselflies of Odonata are very colourful and prominent insects of the wetland.

All animals require a source of oxygen to live. Terrestrial insects draw air into their bodies through spiracles holes found along the sides of the abdoment. These spiracles are connected to tracheal tubes where oxygen can be absorbed. However, all aquatic insects have become adapted to their aquatic environment with the specialization of there structures. Insect respiration has been reviewed by Buck, 1962, Keister and Buck, 1964 and Miller, 1966. They have contributed some aspects of respiration in general insects of Newyork in USA. Allen, 1973 has made Generic revision of may-fly nymphs and also in the year 1978 he has given some ideas on the nymphs of North and Central American Leptohyphes (Ephemeroptera : Tricorythidae). Anderson and Sacther, 1995 have shown the first record of Buchanomyria and subfamily Bachonomyinae from New World. Again in the next year i.e.
in 1996 they have identified new species and records of Beardius (Diptera : Chironomidae). In the year 1996; Dreess and Jacksman have written about diving beetle while Monika *et. al.,* 2005 have thrown light on Salmon resources to aquatic micro invertebrates. Baumgardner, 2007 has identified New species of Leptohyphidae (Ephemeroptera) from Costa Rica. In the same year i.e. in 2007 itself Subramaniam and Sivarama Krishnen have prepared a Field Guide of Indian Aquatic Insects. Ardon and Bringle, 2008 have worked on microbial and insect mediated leaf break down in a tropical rain or forest stream, Costa Rica. In the year, 2011; Gall *et. al.,* have written a brief note on survival and growth of the Caddisfly, Limnephilus flavastellus after predation on toxic eggs of the rough skinned Newt (*Taricha granulosa*).

On the basis of available literature it is clear that no detail work has been carried on wetland insects. It is true in case of aquatic flies which start life in aquatic habitat, grow in aquatic media and then lead terrestrial life on different ecological niche. It is more true in Indian continent. Hence the present work will fill up the lacunae in literature of aquatic insects.

MATERIALS AND METHODS

In order to study, the aquatic insects have been cultured in insect aquarium after obtaining desired stages of the insects from fresh water sources.

Observations of activities of spiracles have been seen under binocular dissecting microscope with objective lenses of different magnifications.

In order to estimate the amount of dissolved oxygen Winkler's method has been applied to get the correct estimation for presence of dissolved oxygen in media where insects were kept in natural condition. The amount of oxygen / litre was calculate as per equation –

$$\frac{K \times 200 \times Vol.\ of\ Na_2S_2O_3 \times 0.698}{Volume\ of\ samples}$$

Where K was - $\frac{Volume\ of\ bottle}{Volume\ of\ samples}$

OBSERVATION AND DISCUSSION

One problem that aquatic insects must

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overcome is how to get oxygen while they are under water. Aquatic insects have tackled the problem of living in aquatic environment by evolving various morphological and physiological modifications instrucure and adaptations according to media. These include airtubes to obtain atmospheric oxygen, cutaneous and gill respiration, the extration of air from plants, haemoglobin pigments, air bubles and plastron. Simple diffusion over a relatively thin integument, breathing through plartron or physical gills, extraction of oxygen from water using plastron or physical gills, storage of oxygen in haemoglobin molecules in haemolymph and taking oxygen from surface via breathing tubes (siphons) are the respiratory adptation in aquatic insects.

Plartron, in aquatic insects, which act as physical gills, is obviously seen a combination of hairs, scales and unulation from the cuticle which hold a thin layer of air along the outer surface of the body.

The platron forms an essential part of the respiratory appratus of insect eggs and also the pupa of aquatic insects. The plartron is specialized structure which hold a permanent thin film of air on the outside of body for gaseous exchange.

Cutaneous and gill respiration has been found in the immature stages of mayflies, drogon flies and caddisflies. This helps there flies while in immature stage to live among submerged substances. Mayflies, dragon flies and Caddisflies in immature stage depend upon dissolved oxygen and these achieve their maximum diversity in running water. In Ephemera a good deal of gaseous exchange takes place through the gills.

Generally in insects, living in water, some inward diffusion of oxygen from the water takes place through the cuticle and in many larval forms gaseous exchange takes place solely in this way. Cutaneous diffusion depends on the permeability of the Cuticle and the lower oxygen tension in the tissues as compared with the water. In Aphelocherius (Heteroptera), for instance, the cuticle of the last instar larva is about four times as permeable as that of adult (Thorpe and Crips, 1946). Cutaneous respiration is important in eggs and aquatic stage of insects. However, the impermeability insect cuticle to oxygen arises from the epicuticle.

Larval Donacia (Coleoptera), Chrysogaster (Diptera) larvae and puparia of Notiphila (Diptera) and the larvae and pupae of mosquito, Monsonia have been found obtaining oxygen by thrusting their spiracles into the aerenchyma of aquatic plants. In these cases the functional spiracles are at the tip of a sharp pointed post-abdominal siphon in larval forms and on the anterior thoracic horns of the pupae.

Some insects have densely packed hairs (setae) around the spiracles that allow air to remain near, while keeping water away from the body. The tracheae open through the spiracles into the air film allowing the access oxygen. They may even carry a buble of air down from the surface.

In Aphelocherius oxygen, taken by tracheae, pass directly to the tissue.

In Simulus larvae, a net work of tracheoles close beneath the general body cuticle has been observed.

Under body cuticle cover a number of leaf

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like extensions of the body has been observed which may act as gills. Some scientists are of the opinion that these are tracheal gills.

In pupae of Diptera and in beetle of the family Psephenidae observed in aquatic media have been found spiracular gills, as extension of the spiracle or the cuticle. However, spiracular gills are functional in air and water both. In pupae spiracular gills help in respiration.

MECHANISM

General Respiratory Mechanism in Aquatic insects

Gaseous exchange in insects is carried on through tracheae, a system of internal tubes, the finer branches of which extend to all parts of the body. The tracheae open to the outside through segmental pores, the spiracles.

Oxygen is carried directly to its sites of utilisation and the blood is not concerned with gas transport.

Process of Gaseous exchange

The spiracles open into the permanent film of air, present on the outside of the body. The spiracles open into the film so that oxygen can readily pass from the water into the tracheae. However, problem facing to aquatic insects have been observed the breaking the surface film when they surface and of preventing the entry of water into the spiracles when they submerg. The case with which this has been accomplished depends on the surface properties of the cuticle and in particular its resistance to wetting.

The inward diffusion of oxygen from the spiracles depends on the partial pressure within the tracheoles being lower than in the outside air.

Returned carbondioxide, instead of passing directly into the tracheal system, diffuse outwards through the tissues and enter the tracheae near the spiracles or passout directly through the integument.

A part from respiration the treacheal system has the function of lowering in specific gravity in aquatic insects and degree of buoyancy.

The spiracles have opening and closing mechanism in response to the concentration of oxygen. The spiracles open in response to a low concentration of oxygen or a high concentration of Carbondioxide in the tissues. The spiracles are normally open for the shortest period necessary for efficient respiration in order to keep water loss from the tracheal system to a minimum. Spiracle closure results from the sustained contraction of the closure muscle, while opening commonly results from the elasticity of the surrounding cuticle when the closure muscle is relaxed.

From the spiracle oxygen passes through the tracheal system to the tissues and ultimately reaches to mitochondira in order to play a part in oxidative processes.

When the insects dives into the water, it carries a layer over parts of its surface. The insect absorbs oxygen from this air as it would above the surface. Diffusion from the surrounding water replinshes the oxygen in the pockets of air. The larger proportion of nitrogen in the air dissolves in water slowly and maintains the gas gill volume supporting oxygen diffusion.

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Mechanism of gaseous exchange and equillibrium in Aquatic media

When an insect dives, the gases in its air-store, are in equilibrium with the gases dissolved in water, assuming that there is saturated with air.

Normally at dive the bubble contains approximately 21 percent oxygen and 79 percent nitrogen, while the water, because of the differing solubilities of the gases, contain 33 percent oxygen, 64 percent nitrogen and 3 percent carbondioxide. Carbondioxide is very soluble so that there is never very much in buble. However, within a short period after diving the proportion of oxygen in the buble is reduced, since the oxygen is utilized by the insect.

CONCLUSION

Tracheae are formed by invaginations of ectoderm and so are lined by a cuticular intima.

Animal species are far more diverse and numerous in inland waters than plants. A part from fishes, invertebrates form an important group including insects. As on land insects are the most diverse group of organisms in inland waters. Aquatic insects are adopted to either running waters (streams and rivers) or standing waters (ponds and lakes). Insect communities of the wetlands respond to the statial temporal variation as well. Unlike terestrial forms, where beetles of order Coleoptera are the most diverse, flies of Diptera appears to be by far, the most abundant group in inland waters.

Aquatic insects have evolved diverse like history strategies to suit their environment. Many species have developed morphological and physiological adaptations to survive in particular oxygen concentration. The distribution being very evident in running aand standing water, where the former is very well oxygenated than latter. This is one important factor that determines the distribution of group like mayflies, stoneflies and caddisflies.

The origin of aquatic insects has been controversial and doubts still exist as to whether or not insects are primarily or secondarily adapted to aquatic environments. The widely accepted view is that the ancestor of myriapod insect group (millipede, centipede and insects) lived in leaf litter areas along margin of ponds like environment. Primitive insects of this moist environment were ancestors of aquatic insects. Their fossil record extends to Devonian in the Paleozoic era. Among extend aquatic insects, dragon flies of Odonata and mayflies of Ephemeroptera are the most primitive and only insects with aquatic juveniles. However, the understanding of aquatic insect evolution and phylogony has been hampered by poor fossil record of fresh water animals.

It is clear that aquatic insects obtain oxygen directly from the air or from air dissolved in water. Insects which obtain air from the water nearly always retain the tracheal system so that the oxygen comes out of solution into the gaseous phase. This is important because the rate of diffusion in the gas phase is very much greater than in solution in the haemolymph. It is also obvious that majority of insects which obtain their oxygen from water have closed tracheal system, that is a system in which the spiracles are nonfunctional. Under these conditions the

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oxygen from the water diffuses through the cuticle and into the tracheal system within which it can rapidly diffuse round the body to the tissues.

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